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Woods Hole Oceanographic Institution

Gulf of Maine Seals - Fisheries Interactions and Integrated Research Final Report

by

O.C. Nichols, A. Bogomolni, E.C. Bradfield, G. Early, L. Sette, S. Wood

Woods Hole Oceanographic Institution
Woods Hole, MA 02543

October 2011

Technical Report

Funding was provided by the Woods Hole Oceanographic Institution Marine Mammal Center and the Provincetown Center for Coastal Studies

Gulf of Maine Seals-
Fisheries Interactions and Integrated Research

Final Report

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Andrea Bogomolni is a Research Associate at the Woods Hole Oceanographic Institution and a Ph.D. student at the University of Connecticut in the Department of Pathobiology. Her research addresses disease persistence in marine animals and how environmental stressors may affect health. In her research, seals continuously have been found to be the ideal representative sentinel species for monitoring ocean and human health. In addition to disease related research, she is also involved in spearheading seal monitoring, counts and individual photo identification in seals in southern Maine/Northern New Hampshire and is dedicated to increasing communication and collaborations to address and answer questions involving seals in the northeast U.S.

Elizabeth C. Bradfield is a naturalist and writer and assists with gray seal field work for the Provincetown Center for Coastal Studies.

Greg Early has worked with marine mammal rescue, rehabilitation research and husbandry programs for over twenty five years and has organized meetings and conferences about pinniped/human interactions on the east and west coasts.

Keith Matassa is Coordinator of the University of New England Marine Animal Rehabilitation Center in Biddeford, Maine. His research interests are multifaceted, but center around new and emerging diseases that affect marine animals and humans including transmission of these diseases, immunology systems of marine mammals and antibiotic resistance. He is also involved in research into the disposal of marine mammals by composting and studies the breakdown of persistent and non-persistent contaminants and pharmaceuticals in the compost pile.

Owen C. Nichols is director of the Marine Fisheries Research program at the Provincetown Center for Coastal Studies and a Ph.D. candidate at the University of Massachusetts. His primary research interests include fisheries oceanography, distributional ecology, and marine mammal/fishery interactions. Key elements of his work are direct involvement of fishermen in all aspects of research projects, and the application and deployment of advanced sensing and imaging technology.

Lisa Sette is part of the Marine Animal Entanglement Response Team at the Provincetown Center for Coastal Studies (PCCS). She is also working on a seal project with PCCS investigating the movements and site fidelity of gray seals as well as the occurrence of entanglement using photo-identification. Currently, she is monitoring several haul-out locations around the Cape and Islands.

Stephanie Wood has worked on several pinniped studies in the northeast U.S. including seal captures and tagging, aerial survey work and food habits studies. She received a Ph.D. in Biology from the University of Massachusetts, Boston. Her dissertation research focused on the recovering gray seal population in the northeast U.S. She is currently a contract biologist for the Northeast Fisheries Science Center.

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Introduction

The 2011 meeting, "Gulf of Maine Seals: Fisheries Interactions and Integrated Research", held at the Provincetown Center for Coastal Studies (PCCS), featured posters and oral presentations as well as a series of discussion groups. This meeting was a follow up to the 2009 meeting, "Gulf of Maine Seals - Populations, Problems and Priorities", held at the Woods Hole Oceanographic Institution (WHOI) (Bogomolni *et al*. 2010). At the conclusion of the 2009 meeting, attendees emphasized the need to improve communication, to obtain funding for long term research, to continue meeting on a regular basis, to increase data and data sharing, and to support cross cutting research between the meeting's three primary topic areas: disease and health; human and fishery interactions; and population biology.

The overarching goals of the 2011 meeting were to discuss and share work to date, present some of the tools developed since the 2009 meeting, and outline goals for future integrated research. One of the tools presented within the framework of cross-cutting research areas and integrative research was the development of a sightings database and website for uniquely identifiable (unique pelage, scars, lesions, tagged, branded, marked, etc.) animals. The practicality of this tool as a means to increase communication was discussed.

Additionally, seal/fisheries interactions throughout the Gulf of Maine, Cape Cod and waters off of the northeast U.S. have continued to concern stakeholders since the 2009 meeting. The urgency of documenting, understanding and mitigating these interactions has become more apparent. Therefore, the focus of the 2011 Provincetown meeting was on fisheries interaction and related topics raised at the last 2009 workshop and in the meetings with Cape Cod fishermen described below. For the purposes of this report, 'fisheries interaction' can be direct/operational (*e.g.* depredation, when seals remove fish from gear; or entanglement/bycatch, when seals are unintentionally captured), or indirect/ecological (competition, displacement or other large-scale interactions between seals and fisheries).

Stakeholder concerns about fisheries interactions and recent increases in local seal abundance were rising prior to the 2009 meeting. In December of 2006, the Chatham-based Cape Cod Commercial Hook Fishermen's Association (CCCHFA) took the lead in organizing a meeting entitled, "Structuring a Novel Research Team to Define and Assess the Impact of Human/Seal Interactions on Cape Cod/Gulf of Maine through Ecosystem-Based Analysis". Participants included fishermen, policy makers, environmental organizations and researchers aiming to develop a unique partnership to study the New England seal population. The goal of this meeting was to create a research team that would define the ecological role of seals in Cape Cod waters by studying population dynamics, behavior, and health. This meeting resulted in a successful partnership, financially aided by the International Fund for Animal Welfare (IFAW), between fishermen and seal researchers. A cost-effective cooperative research agreement was reached whereby seal researchers were provided boat transport around the Chatham and Monomoy areas by local fishermen. This agreement allowed students and researchers to gain access to areas off of Chatham that would otherwise not have been accessible. It also supported a collaborative effort to increase understanding and communication between stakeholders.

In addition to the CCCHFA-led meeting in 2006, a series of informal meetings have been held on Cape Cod between commercial and recreational fishermen and marine scientists. This work was initially funded by the Cape Cod Five Cents Savings Bank Charitable Foundation. Owen Nichols and Lisa Sette (PCCS) have held individual meetings with commercial fishermen in Chatham, Orleans, and Provincetown, and recreational fishermen, outfitters, and associations throughout the Outer Cape. These individual meetings were followed by larger group meetings in Eastham and Chatham in 2010 and 2011, and more are planned for 2012. Attendees included commercial and recreational fishermen and scientists, and discussion topics included observed seal/fishery interactions and potential collaborative research projects. The goal of the meetings is to develop a working group composed of members of the fishing and scientific communities with expertise in marine mammal and fisheries ecology.

The above meetings laid the foundation for the 2011 meeting, during which members of the scientific and fishing communities gathered to focus on fisheries interactions and integrated research techniques to quantify and mitigate interactions. Several invited presentations were given, some of which were scheduled (Appendix A) with selected abstracts provided (Appendix B), and some of which were delivered on an *ad hoc* basis upon request from organizers or attendees (see Appendix F for edited transcripts of presentations). In order to ensure that the fishing community had a distinct voice, a forum was included in the agenda, during which fishermen were encouraged to share their observations, experiences and concerns. Separately, moderated discussion groups focused specifically on fisheries interactions, tagging and tracking, and management issues. All four sessions, despite their specific foci, shared common themes such as the need for collaborative research involving both the scientific and fishing communities. Recommendations from the discussion groups and summaries from each session are listed on the following pages.

Recommendations from the Provincetown Meeting

Tracking Website and Database

1. Improve data sharing and communication on movement of seals and reporting interactions with seals.

2. Develop a database to allow researchers to re-sight individual and identify tag/marking origin to gain understanding of individual movements and monitor changes in population and environment.

3. Create an easy to use web interface that has a public component as well as a second tier for secure data management.

Tagging and Tracking-

1. Compile and map historic tracking data of tagged seals for the Northwest Atlantic.

2. Seek funding for integrated research involving biologists and fishermen to identify areas where there is an overlap of seals and fisheries.

3. Coordinate research efforts in order to take advantage of limited resources to answer short term and long term questions regarding seal behavior.

Fisheries Interactions-

1. Address data gaps: seal spatiotemporal distribution, seal abundance, and prey composition and consumption.

2. Review existing ecosystem models and assess efficacy of application to quantifying seal competition with fisheries (in the Northeast U.S.).

3. Conduct an effort to collect data on depredation in fixed-gear fisheries, using existing observer data and fishermen's observations, and develop a standardized protocol for documenting depredation (time, place, depth, species, etc.).

Management-

1. Create a clear message and proposal with costs associated to address data gaps (how many seals, what do they eat, measures of competition, depredation rates, cod worm relationship, disruption to spawning behavior).

2. Determine if there are alternate management practices which can be used to address issues (depredation, behavior changes of seals/fish, competition).

3. Many key issues were addressed in the working group section (see key issues)- In summary, good data and long term research projects involving fishermen, managers and scientists are needed to address these questions.

Mandate

As part of the effort to improve collaboration and communication amongst stakeholders, the formation of a northeast U.S. pinniped consortium and adoption of a mandate was proposed. The following mandate and consortium structure was presented by the meeting organizers to the group at large.

"To improve our understanding of the ecological role of seals in the northeast U.S. This will be accomplished through coordinated research efforts, sharing of data, collaboration amongst all stakeholders, a concentrated effort to gain knowledge, and public outreach. The consortium would include scientists (NGO's, universities, state and federal government), fishermen (commercial and recreational), and anyone who shares an interest."

Consortium Structure/Goals:
1. Formation of a centralized database with explicit data sharing agreements.
2. Obtain funding for long-term research.
3. Increase communication between researchers and increase coordinated research efforts.
4. Provide the public at large with information based on solid research.
5. Establish a long-term research site.
6. Will meet on a regular basis (~every 18 months).

A Perspective on Our Future Direction

by Greg Early

Interactions, positive and negative, between seals and people are nothing new. Some of the earliest conservation measures protecting seals as well as some of the earliest programs for controlling and reducing seal populations have occurred (nearly simultaneously oddly enough) in the Gulf of Maine

At the 2009 workshop, participants created an extensive list of issues relating to seals in general and human/seal interactions in particular. The list, as one might expect, was long. Participants also created a list of research areas, projects and tools that could be used to shed light on the issues of the first list. That list was long as well. Participants also created a list that could be used to help address some of the issues. This list was, to no one's great surprise, quite a bit shorter than the other two. Finally, the group put together a list of potential sources of support for closing data gaps, research and ongoing work to address issues. This list, again to no one's great surprise, was shortest of all.

So why be concerned? And why be concerned now?

We've all seen headlines – "seal populations exploding" – so are there more seals, and are they a bigger problem now? There probably are more seals, but more since when, and by how much? Seals are probably being seen in greater abundance in places where they have not been seen in recent memory, so they are probably moving into new, or at least different areas of the coast. The problem here, is not those observations, the problem is the "probably". Even best guesses about the most basic facts – how many are there – where are they – and what are they doing, are based in very little actual, solid data. We have very few good facts to go on.

Do more seals necessarily mean more problems? The answer is probably both yes and no, unfortunately. For example, with more seals in an area some events - for example a mass die-off (i.e. distemper in Europe) would simply, because of the sheer numbers involved, have a greater impact. One mass die-off in 1979/1980 killed by some estimates as many as 90% of the seals on the largest seal haul-out in Cape Cod Bay at the time. What was a mortality of roughly 500 seals then would be considerably larger now scaled to present population estimates.

What about seal/fishery interactions? Surely these would increase with increasing population. Maybe, but consider if much of the direct seal impact is caused by a relatively small segment of the population. Or conversely, consider if a fishery is selectively impacting a certain demographic of the seal population. Seal/fishery interactions are exceedingly complex and depend on habitat use and resource competition at direct and indirect levels and our assumptions are based on thin data and a much generalized view of those relationships. As such there is a lot of "probably", few facts and more need for better information.

But there is some good news. Although there has been and still is little financial support for wide scale seal research, there are many new and improving tools for research collaborating and communicating. Tools such as small digital cameras with GPS capability were tools that only years ago could only be afforded by research organizations or scientists with a well funded research grant. Telemetry is now small enough and sophisticated enough to give us huge insights into the lives of these cryptic animals. The tools are becoming available to better understand the questions of how many, where are they and what are they doing?

Data gathering capabilities that were once only available to research organizations are now in the hands of the general public. This has the potential to vastly increase data gathering capacity.

With on-line networking and data collecting and collaboration, widely distributed information can be gathered and shared. Thus, there are both more potential data gathering sources and an increasing capacity to share and distribute that information. This has the potential to give a whole new perspective.

So the really good news – and the reason why now is a good time to be focusing on these issues is that while seal populations are "probably "increasing – the amount and sophistication of information that can be gathered by individuals has definitely increased and is definitely increasing.

What is certainly exploding then, is the capacity to gather and exchange essential information for addressing the issues that people have been grappling with for as long as there have been pinniped/human interactions.

What do we need?

Well, unlimited funding would be nice, but not likely.

So why be concerned about and trying to address these issues now? The answer seems to be less about changes to seal populations - that are always changing - or changes to problems – that are always around - or changes to attitudes about seals or wildlife in general – what is changing now, and rapidly are capabilities to collect and share information. This is the present change that hopefully provides the opportunity to better address those persistent, but nevertheless important problems.

How can information sharing improve? Participants from both workshops indicated that the answer is - with more focus – both for efforts and output – more general collaboration – more utilization of existing resources – greater community – centralizing data and providing an ongoing forum for continued exchange.

More frequent meetings both for stakeholders and researchers – whether these become formalized into a definable organization – thorough a structured mandate and scope of work – is yet to be seen – but whether structured or unstructured these meetings point to the basic need to

share and communicate information across stakeholder groups – in a variety of ways and in a variety of settings.

The challenge this presents is how to better communicate, network, collaborate and share. What we have found from past meetings is that the one thing that we can be sure of is that people – stakeholders, scientists and the general public, want to communicate and share information and that now is the time when there are many new and useful tools for collecting, examining and disseminating that information and perhaps addressing that first long list of issues.

Meeting Summary

Tracking Website and Database Discussion

Several priority areas were established during the 2009 workshop, "*Gulf of Maine Seals: Populations, Problems and Priorities",* workshop held at WHOI. One which overlapped all three working groups (Human and Fishery Interaction; Disease and Health; Population Dynamics) was the desire for improved data sharing and communication. However, while the desire to share information exists, a means to share the data does not. Tagged (identifiable) animals can provide important data on human/fisheries interactions, health and population dynamics.

The costs associated with tagging marine mammals spans from a few dollars for the tag plus the operational costs of stranding response, on-board observer and field work needed to adhere the tag (paint stick/ cattle tag/ flipper tag/ branding/ hat tags), to the thousands for placement of tags (mortality tags/satellite/pop-up/D-Tag), retrieval and data analysis. In addition, the welfare issue involved in being able to quickly identify and respond to reports of unique markings, specifically entanglement or injury that could compromise an animals' survival, are equally important in cost benefit analysis in this type of mark-recapture. The benefits of recapturing/sighting individuals are tremendous for multiple reasons, including an increase in understanding of marine mammal and ecosystem sciences, conservation, welfare and future rationale on the expenses and cost associated with tagging.

As a solution to this problem, we proposed the development of a website to increase the ease and rate at which opportunistic sightings of tags, unique markings and unique events can be recorded. This website would be accessible to both citizen scientists and professional scientists (naturalists, researchers, fishermen, beach goers and any ocean user). The website will be developed with an easy to use front/user end and an expandable back end including a database with relational capacities. This will allow for the development of a usable and integrative tool with the capacity for optimizing the information that can be gathered from opportunistic observations. This website could also be a means to report unusual marine events with broader impacts.

A two-tiered approach to the development of the site will allow for future modification. The first tier would include a visual layout of all tags or markings archived or used in the region (Canada to the Caribbean). The user can click on the tag and learn about the researcher or project associated with that tag. Highlights and links from each researcher/tagged individual will be featured on the front end of the sight as well as direct contact information. This information will also be available in a printable PDF format.

The site would include two methods to report a tag. The first would be a search form with stepwise progression which would generate a report with possible tags (photo front and back) that fit the user's criteria (animal type tagged: tag type: color of tag: tag material: placement on animal). The user can then click on the appropriate large icon representing the tag/marking type

that appears to be the one they identified and fill in a report. A second parallel feature will exist to report a tag without looking through the search criteria with an easy to fill in form. A reverse search option will also be available to determine what sightings in the database exist for each known researcher/tag and generate a report of sightings data. To access this data, a user must create an account and agree to terms of the database. Similarly, researchers who tag or are interested in marked animals, can input their sighting data into the database through a password protected interface.

An option would also be available to submit photos or video and report unusual or other events of interest. This will allow for other types of data to be recorded and if necessary and sent to the appropriate organization (*e.g.* SEANET, state fisheries, DNR, Smithsonian). All data will be sent to a database administrator when the user confirms the entry. From there the data and images will be verified by an administrator and data entry approved. Confirmed tag sightings will be visually displayed on the front end using map positioning information.

The second tier of this tagging tool would allow for data entry of tag data by the originator of the tag. Improving the capacity to visualize tag data and manage data for pinnipeds in the eastern U.S. in particular, would greatly improve data sharing and communication in the region. Use of this tool would depend on the needs of those who generate data on tagged pinnipeds and other marine mammals in the region.

Currently, the first step of this database effort is underway. The database and website were presented at this meeting and is in the last stages of development, hosted by WHOI and called the Marine Animal Identification Network, (main.whoi.edu – note no "www") to be fully launched September 2012.

Recommendations of attendees re: Tracking Website and Database Project

- Provide guidelines for approaching/interacting with marine mammals on homepage.
- Monitored site on regular basis with a prompt for reporting emergencies in real time for stranded/entangled animals in distress.
- Provide automatic (RSS feed/email alerts) updates to all subscribers of sighting reports and promote citizen science.
- Create an application ("app") to report sightings.
- Data sharing models exist to insure proper usage and importation of information which can be used here.
- Produce a database that can interact easily with other databases (Oracle based and MYSQL based including the National Marine Mammal Stranding, Observer Program, etc.) by implementing the same fields and characteristics.
- Consider re-organizing methods for tagging identification for future tagging/tracking of marine mammals in the northeast (West coast model).

Key Issues:

1. There is a common desire for improved data sharing and communication on movement of seals and reporting interactions with seals.

2. A database would allow researchers to re-sight individual and identify tag/marking origin to gain understanding of individual movements and monitor changes in population and environment via anecdotal information.

3. The platform for this database should be through an easy to use website interface that has a public component as well as a second tier for secure data management including terms of use.

Tagging and Tracking Discussion

Rob DiGiovanni from Riverhead Foundation for Marine Research and Preservation moderated the seal tagging and tracking section. The session began with a question: How can we effectively look at fine-scale and large-scale movements of seals using available tagging technology? The group first discussed tagging work completed over the past 25 years throughout the northwest Atlantic on stranded and rehabilitated seals that have been released and tagged. Concerns were raised that the data from stranded seals might be biased. However, using tagging data from stranded seals in conjunction with data from healthy seals might generate a better picture of how the seals behave seasonally on shore and off shore during haul out periods, feeding forays and breeding season.

The discussion then shifted to observations from the fishing community. They added that they observed seals interacting with their nets and having impact on their hauls. To quantify these interactions a number of questions were identified which could be answered by identifying, marking, or tagging individuals: How are seals interacting with fisheries? What percentage of the seal population interacts with fisheries? Are there a large number of animals going after fish in nets or is it just a few individuals that are "repeat offenders"? Do the seals in specific areas disperse the target species from the nets?

A variety of technologies and methods to investigate these questions were discussed. It was cautioned that it is important to identify which questions were primary and then use the appropriate methodologies to investigate the issues. Working collaboratively with the fishing industry to obtain data on animals encountered in their nets, and deploying tags on animals encountered would provide some insight on seal behavior.

The discussion then shifted to integrated research and the different types of tagging technology currently available. The group agreed that getting tags on seals will help answer fishery interaction questions and broader population questions. With limited resources being an issue, the research community and fishing community need to collaborate and possibly look into using multiple types of tagging technology to better understand seal behavior.

Key Issues:

1. Biologists, fishermen and managers need to better understand seal behavior, localized and long distance movements of seals.

2. Fishermen observe degradation in their catch, possibly due to seals.

3. How do we answer these questions with limited resources?

Management Discussion

The management section was moderated by Erin Burke of the Massachusetts Division of Marine Fisheries and the meeting organizing committee. Discussion began with the understanding that there is a lack of information to manage fish stocks as well as marine mammals. Much of the early discussion focused on international (e.g., Canada, Norway) pinniped management practices and the type of information used to inform management, including modeling seals impact on fish stocks, and the results of these management practices.

Several knowledge gaps were identified, including population structure, distribution, demography, and further documentation of fishery interactions. Early on, one of the issues discussed included clarification on the overall population structure of gray seals. While local issues exist in relation to the species, the population is made of one large NW Atlantic population distributed between Canada and the Northeast U.S. The level of interchange between U.S. and Canadian breeding animals is an important data gap.

The members of the workshop collectively asked what specific information was needed for managers to better address the issue of fishery interactions and seals. Several specifics were identified including: more information on seals diet and consumption of economically valuable species; spatial association and seal foraging behavior (e.g., depredation, discards) around fishing vessels; the role of seals in dispersing and disrupting aggregations of spawning cod fish; and the effects of seal abundance on prevalence of cod worm infestation in economically important groundfish. Additionally, several references were made to overall reduction in biodiversity in Nantucket Sound and surrounding areas. In this regard, overall ecosystem level changes need to be addressed when determining the effective changes in fish abundance. In addition, these information gaps pertain to both near-shore and off-shore habitats, and require an estimation of the proportion of the seal population that interacts with fisheries.

The working group members then posed the question of how this information could then be used in management to aid fishermen. Several attendees with a role in management noted that management requires stakeholders to present a clear message of what needs to be done and the costs associated in order to push for the funding and political action needed to address these issues.

Key Issues:

Information gaps exist for management. Several gaps were identified including those relating to population estimates and measured competition for resources. For management to move forward these priorities were identified:

1. Mortality: What is the natural mortality vs. fisheries mortality? And what proportion of that natural mortality comes from seals? Similarly, in regards to mortality and fish health: what is the relationship between the seal population and current levels of cod worm (*Pseudoterranova decipiens*) seen in target and non-target fisheries species?

2. Depredation: what is the level that occurs inshore vs. offshore?

3. Behavior: Is seal behavior disrupting spawning and redirecting fish and to what degree? If so, can these behaviors be modified? Similarly, can behavior be modified in regards to discards and presence of seals?

4. How do seals fit in to changes seen in ecosystem at large?

Fisheries Forum

The fisheries forum was moderated by Owen Nichols. Members of the fishing community were encouraged to share their experiences and observations with the group. Commercial fishermen noted extensive depredation in fixed-gear fisheries, both inshore (Nantucket Sound weirs) and offshore (gillnet south and east of Chatham). A discussion ensued about monitoring depredation in the weir fishery (see abstract by Nichols *et al*., Appendix B), and the efficacy of physical barriers or other deterrents to exclude seals while allowing target species to enter. The implications of catch damage and loss for gillnetters targeting groundfish were discussed. Fishermen noted increases in the range and depth of depredation events and noted that some are fishing other habitats (north of Cape Cod, Stellwagen Bank) in response. Management implications of depredation raised included instances of seal-damaged fish counted as discard mortality against catch limits/quotas. Fishermen shared concerns and posed hypotheses regarding seal-induced displacement of groundfish from spawning areas, localized depletion of both target and non-target species in inshore habitats, and impacts of seals on water quality in bays and estuaries.

Charter and recreational fishermen fishing in Cape Cod Bay have noted declines in finfish (bluefish) catches around Wellfleet and inshore striped bass landings around Pleasant Bay and the eastern shore of the Cape, attributed to seals. Seals have been observed taking fish off lines and preying on free-swimming fish around charter fishing boats. Similar accounts were expressed by those involved in the commercial and recreational striped bass fisheries. Concern was expressed about the fate of released fish in the presence of seals.

Across all fisheries, there were accounts of seals feeding only on the bellies of fish, whether caught in gear or free-swimming. Several fishermen expressed concern that no abundance estimate exists for local seal populations, and the lack of information about the ecosystem role of seals. Many fishing community members were also concerned about the fisheries management system's ability to account for increasing and spreading depredation, as well as changes in ecosystem function, with increasing local seal abundance. Virtually all of the fishermen and association representatives expressed eagerness to work with scientists on cooperative research.

Key Issues:

1. Seal depredation in commercial and recreational fisheries is increasing in frequency and expanding in geographic range.

2. Declines in landings of both target and non-target are attributed by fishermen to seal presence and predation.

3. Fishing community members are concerned about the fisheries management system's ability to account for increasing seal/fishery interactions.

Fisheries Interaction Discussion

The fisheries interactions discussion was moderated by Owen Nichols and focused on two types of fisheries interaction: competition (larger-scale ecological interaction in which seals and fishermen compete for target species or otherwise interact at an ecosystem level); and depredation (small-scale operational interaction in which seals remove catch from fishing gear). A third type of interaction, bycatch (seals incidentally captured in fishing gear), was not discussed due to time constraints. However, depredation and bycatch are closely related, as depredation attempts can lead to entanglement (Read, 2005; 2008).

The discussion of competition centered around the data requirements necessary to demonstrate evidence of localized depletion of species targeted by both seals and fishermen. Initial discussion focused on existing long-term fisheries landings and survey data sets and how to incorporate them into models of competition. Participants noted gaps in the knowledge of seal spatiotemporal distribution, abundance, and prey composition and consumption. The utility of models as a heuristic tool for understanding ecosystem function was discussed, as well as the applicability of existing models in use in other ecosystems. Two posters presented (Col *et al*., Neuenhoff *et al*., Appendix B) outlined approaches to quantifying marine mammal consumption and competition with fisheries.

The group began a discussion of depredation by focusing on at-sea data collection (i.e. fisheries observers) and the efficacy of using existing data to quantify depredation in fixed-gear (e.g. gillnet) fisheries. The need for scientists, observers and fishermen to work together to document

depredation (time, place, depth, species, etc.) in a standardized manner across fisheries was discussed, as well as the need for such information to help fishermen make decisions about how to modify fishing practices to reduce lost catch. Management implications of catch damage and loss were also discussed. A brief discussion of the potential utility of acoustic deterrents ensued, in which fishermen raised concerns about costs of devices, while scientists noted that traditional 'pingers' used to deter other marine mammals may not work given the experiences with the aquaculture industry in Maine, and that physical deterrents might work better.

Key Issues:

1. Fishermen are concerned about localized depletion of target species, but competition between seals and fisheries is difficult to quantify.

2. Depredation results in catch damage and loss in (fixed-gear) fisheries, with significant implications for fishermen and management.

3. Known deterrent or mitigation methods are not thought to be effective in reducing depredation in local fisheries.

Participant Perspectives

During the above discussion sessions, participants were encouraged to speak candidly and openly regarding interactions between seals and fisheries, management issues, and research directions. A full transcript is not provided here, however the authors feel that the following quotes are representative of the range of perspectives shared during the sessions.

"*We need more than* (seal) *numbers. We need to know who's doing what, where, and when. That information might be independent of population numbers."* (Unattributed)

"*The industry and conservationists are talking past each other on consumption. Industry says seals eat too much fish. Conservation says no, they're opportunists. We need to know what seals eat and how much.*" (Fishery Manager)

"*It's important to tag seals that are 15 miles off shore – we kind of know what the ones near shore are doing, but what about the ones offshore?*" (Fisherman)

"*We need to get a sense of a day in the life of a gray seal. Where do they go? What's their effort? What's the overlap with fisheries? What places do they NOT overlap? What's the amount of effort an animal makes on foraging trips – what are its energetic needs?*" (Scientist)

"*The goal is to make the situation better for fishermen, but there are a lot of gaps that need to be filled in.*" (Fishery Manager)

"*I've seen no research that shows that fisheries have improved post-cull*" (Fishery Manager)

"*The fishing fleet is required to be focused on certain prey species because of management restrictions. Seals are very non-specific. Look at the mess of the food web. If we reach into the web, yank on a string, hope we get a positive response on the end of it through a cull, it's a tricky business. I caution against an easy cause and effect.*" (Scientist)

"*How many fish are being taken? Are seals always near boats? Can they be seen from planes? Can we integrate with right whale research?*" (Fisherman)

"*Can we look at the behavior of the fishery and find ways to mitigate interaction or the opportunity for interaction? Is throwing out fish attracting more seals? Does it attract seals to fish on the line?*" (Scientist)

"*In fisheries that promote discards, the seal is there because the boat's there. It is all learned behavior.*" (Fisherman)

"*I don't think the decline in biomass is due to seals eating fish. It's not fully related to that. Maybe in part. I think it's more that they're redirecting the fish? The fish come up to a wall of seals, and they turn. We're seeing stuff that has disappeared out of Nantucket Sound that shouldn't have. Sea robins? They're not a marketable species, so why have they disappeared? We need to look at examples like that to see if the seals are at fault.*" (Fisherman)

"*There's a lot of data out there from strandings, too. How comfortable are we with releasing that data and opening it? One of the problems years ago was that when people were out tagging animals, everyone was doing it differently. Eighty tags were used over the last 10 years, but they might not be comparable? We need to think about that.*" (Scientist)

"*I've never been asked that question* (re depredation). *We catch a lot of flounder with canine-shaped bites out of dorsal fins that didn't hurt the fish. I've never been asked what made them.*

I've had 20-30 different people on board, maybe 100 or so instances of having folks on board. I'll start keeping a record, photographing all fish that come on board that look like they've been gotten by seals." (Fisherman)

"*As someone involved in take reduction teams, it's very useful to get fishermen's perspective on why they think it's happening. Different fish? Different depth? Different area? The fishermen know when they got more damage or less damage? That information is helpful. It helps us make decisions like changing hooks, depth, time of day they fish, fences on weirs. Making decisions about what to try to do to reduce depredation is definitely something you want*

fishermen's input on. Then, you need to back that up with a model. I wouldn't want to go forward without hearing from people who are seeing it happen." (Fishery Manager)

"*If there are different solutions possible, we need to consider which is better sociologically. Which solutions allow fisheries to continue and thrive?*" (Fishery Manager)

"*We are also trying to put a face on the work - give it a presence. To let these issues have real continuity, to have focus, to have a face. It is hard to do as individual stakeholders and researchers. Collectively, we might be able to do it.*" (Scientist)

Literature Cited

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Appendices

Appendix A: Workshop Agenda

8:30 AM: Check in, coffee and light breakfast will be served

9:00-9:30 AM: Welcome and Introduction

9:30 AM-11:45: Presentations

9:30-9:45 **Monitoring seal depredation in the Nantucket Sound weir fishery.** Owen C. Nichols, Ernie Eldredge, and Steven X. Cadrin

9:45-10:00 **Assessing spatial and temporal overlap between fisheries and foraging gray seals using high-resolution cell phone tag technology**. David W. Johnston, Ari S.Friedlaender, Katie Moore and Lisa Sette

10:00-10:15 **Marine Mammal Stranding Networks- Overview.** Kristen Patchett

10:15-10:30 **Observations of external fisheries interactions in stranded pinnipeds on Cape Cod and southern Massachusetts 2000-2010.** Katie Moore

10:30-10:45 **The ecological role of the gray seal as a prey species**. Greg Skomal

10:45-11:00 **Too Many Seals in the Sea?** Sharon B. Young

11:00-11:30 Coffee break/ Poster Viewing

11:30- 12:15 PM: Introduction and Discussion: **Website/Database** to Track Uniquely identified Pinnipeds.

12:15- 1:00 Lunch (provided)

1:00- 2:00 **Fisheries Forum** /Discussion

2:00- 2:15 Coffee Break

2:15- 5:15 Joint Working Groups and Discussion

1. **What are we still missing when it comes to seals? -Integrated Research: Tracking and Tagging**
2. **Seal/Fisheries Interactions**
3. **Management: Implementing Strategies for all Stakeholders**

5:15- 6:00 Summary remarks– Future Direction.

6:00 Catered Reception- Far Land Provisions, Provincetown, MA

Appendix B: Abstracts

Poster Presentations

Seal populations of the Isles of Shoals, ME, USA: Monitoring potential indicator populations of harbor and gray seals through survey and photographic mark-recapture

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The ledges and islands within the Isles of Shoals, which lie at the border of New Hampshire and Maine (USA), are an ideal haul out site for harbor and gray seals within the Gulf of Maine. The location is also the site of the index case for a recent seal mortality event where the only existing strain of phocine distemper virus in North America was isolated. Changes in abundance at the Isles of Shoals may indicate changes that should be monitored throughout the Gulf of Maine. Using photographic abundance surveys and photographic mark-recapture techniques, population composition at the Isles of Shoals was assessed in May and June 2011. Few data exist from aerial surveys and previous long term abundance estimates have not been established for this haul out. Our preliminary results indicate a surprisingly high total population abundance at this site, which has an area of only 0.385 km², of approximately 500 gray seals (*Halichoerus grypus)* and harbor seals (*Phoca vitulina)*. The haul out site included individual seals identifiable by their distinctive pelage patterns, scars, entanglements, lesions, and tags. This survey serves as a baseline for continued monitoring of the Isles of Shoals harbor and gray seal populations.

Estimating Consumption by Gray and Harbor Seals on the Northeast US continental shelf

Laurel Col[1,2], Jason Link[1], Steve Cadrin[2], and Debra Palka[1]
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Due to recent increases in pinniped abundance off of New England, there have been a number of questions raised regarding the impacts of seals through their consumption of commercially and ecologically important fish stocks. This study provides initial quantitative bounds on gray seal and harbor seal consumption on the Northeast US continental shelf for ten prey groups including flatfish, large gadids (cod, haddock, pollock), hakes, clupeids, scombrids, sandlance, miscellaneous fish, squid, shrimp and benthic invertebrates. Ranges of daily individual consumption and diet composition were compiled from literature values, and consumption was expanded to annual, population levels based on abundance estimates of gray and harbor seals in the area. Bounds on consumption estimates of gray seal and harbor seal populations were determined using Monte Carlo simulations, and total pinniped consumption was then summed for each prey group. Results indicate that pinniped consumption may be similar in magnitude to

commercial fishery landings for some prey groups, although previous studies have indicated that targeted sizes may differ. These results are highly dependent upon abundance estimates of seal populations, which are projected to increase in this region. Therefore, obtaining updated estimates of pinniped abundance is crucial. Collectively these results imply that pinniped consumption should be more explicitly included a natural removal from prey populations when assessing fish stocks, and will be important to incorporate into whole-system ecosystem models as we move towards ecosystem-based fisheries management.

A multispecies ecological approach to assess grey seal predation and environmental effects on the recovery of Atlantic cod in the Gulf of St. Lawrence

Neuenhoff R., M. McAllister, A. Trites
Department of Zoology, University of British Columbia, Vancouver, BC, Canada

A collaborative research initiative between multiple Canadian stakeholders (fishermen, academics and agencies) is seeking to test the hypothesis that grey seal (*Halichoerus grypus*) predation inhibits the recovery of the Atlantic cod (*Gadus morhua*) in the Gulf of St. Lawrence. Our objectives are to 1) create an age-structured, multispecies, population dynamics model for Atlantic cod, 2) include major predators, prey, and fishery interactions, 3) incorporate functional responses such as temporal and spatial dietary shifts, and predator avoidance mechanisms, 4) determine critical threshold levels that grey seals could keep cod below, and 5) explore mitigating management actions that will enhance the stock in the Gulf of St. Lawrence. For the first phase of this project, we constructed a multispecies, age-structured model for Atlantic cod. This simple yield-per-recruit model estimates total catch per cohort by simulating multiple recruitment scenarios. It addresses the assumption that annual recruitment of Atlantic cod is stable, and identifies basic trends that result when setting annual harvest rates in relation to stock-recruit success. We incorporated mortality from grey seal predation as a proportion of 1) annual natural mortality (M) or 2) annual fishery mortality (H) that impacts the fishery share of total allowable catch (TAC). The next phase of our study will use model inputs from projected, current and archived DFO data to predict total annual catch under a number of prescribed management actions. We will assess spatial and temporal analyses and functional responses of cod in relation to rates of grey seal predation and seasonal dietary shifts to test the hypothesis that grey seals keep cod in "predator pits" resulting in annual consumption rates that could prevent recovery. This approach is similar to an existing model available for Pacific rockfishes. Multiple harvest scenarios will be summarized in a decision table in order to demonstrate tradeoffs of several possible management actions, and economic costs and mitigation strategies will be addressed in a future presentation. Research outputs from our working group will contribute to understanding predator/prey relationships with respect to stock enhancement and fishery recovery in the Gulf of St. Lawrence.

Oral Presentations

Assessing spatial and temporal overlap between fisheries and foraging gray seals using high-resolution cell phone tag technology

Johnston, D.W.[1], A.S. Friedlaender[1], K. Moore[2] and L. Sette[3]
[1]Duke University, Durham, NC
[2] International Fund for Animal Welfare, Yarmouth Port, MA
[3] Provincetown Center for Coastal Studies, Provincetown, MA

Gray seal population growth and range expansion in the eastern US has lead to increased operational interactions with fisheries (e.g. bycatch, entanglement, depredation and damage to fishing gear – see Waring *et al.* 2010) and raised concerns about possible ecological interactions with fisheries. In many areas, local fisheries stakeholders are increasingly concerned about the potential for competition between seals and fishermen, although no actual studies of this phenomenon exist (Bogomolni *et al.* 2010). Unfortunately, the data required to identify, understand and potentially mitigate operational and ecological interactions between seals and fisheries, and assess their significance to seals, fish stocks and fishermen, are severely lacking. To address these shortcomings, this project aims to provide baseline data on the movements and foraging behavior of gray seals in the Cape Cod/Gulf of Maine region and analyze them in an advanced Bayesian geospatial framework (e.g. Shick et al 2008). These data and modeling results, when combined with publically available records of fishing effort and activity will provide the first insights into how and where gray seal foraging movements overlap in time and space with fisheries.

Monitoring seal depredation in the Nantucket Sound weir fishery

Nichols, O.C[1,2], E. Eldredge[3], and S.X. Cadrin[1]
[1]School for Marine Science & Technology, University of Massachusetts - Dartmouth
[2]Provincetown Center for Coastal Studies, Provincetown, MA
[3]Chatham Fisheries/Monomoy Trap Co., Chatham, MA

Gray seals *(Halichoerus grypus*) have been observed feeding on fish weir catches in Nantucket Sound (Massachusetts, northeast USA). Partially consumed longfin inshore squid (*Loligo pealeii*) and finfish in the nets recorded in logbooks are attributable to seal depredation. A Dual-frequency Identification Sonar (DIDSON) was deployed in a weir for six ~24-hour periods in May and June 2009 to monitor diel patterns of squid and fish catches, as well as seal presence and behavior. Seal occurrence in the weir was observed throughout 24-hour periods, most frequently at night. Observations of seal and target species behavior indicated that seal presence likely affected the efficiency of the weir, disrupting the passage of schooling squid and finfish into the catch chamber. The species composition of catch and prey remnants in the weirs will be analyzed to examine seal prey preference, and photo-identification studies are planned to determine if random individual seals raid the weirs or if there is individual specialization by a select few. The above data will be used to inform the design of gear modifications to reduce depredation by excluding seals while maintaining catches of squid and fish.

Too Many Seals in the Sea?

Young, S.B.
The Humane Society of the United States , Washington, D.C.

On both coasts there are situations in which some believe that there are "too many" seals or sea lions. At Bonneville Dam in the Columbia River basin, the states of Washington and Oregon have applied to intentionally kill them. Incidents of illegal killing have also risen on both coasts. Populations of most seals and sea lions are considered robust. But what is "too many?" What options are there if they are considered a nuisance or if their populations are approaching a biological or sociological carrying capacity? This talk will illustrate several conflict situations and what has been proposed to address them, both in a regulatory context and in proposed changes to existing legislation.

Appendix C: Participant Contact Information

GULF OF MAINE SEALS- FISHERIES INTERACTIONS AND INTEGRATED RESEARCH

CONTACT LIST

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Appendix E: Post Meeting Survey Results

1.

How would you rate the single day meeting/workshop format?		answered	skipped
		15	0
Too Short	0		
Short	1		
ok	11		
long	3		
too long	0		

2.

The morning session of the workshop consisted of short (15 minute) presentations. Would you prefer longer (but fewer) talks?		answered	skipped
		15	0
yes	1		
no	14		

3.

What is your opinion of the overall group size-				answered	skipped
				15	0
	too small	just right	too large		
of the meeting	1	13	1		
of the working group	1	10	2		

4.

List presentation that you found particularly useful or that could be omitted	answered	skipped
	6	9
Useful		
hi tech tagging		
fish weirs- but shorter		
admission of how little we know		
Fish weir predation		
the research on predation in weirs		
seal identification		
white shark; tag data base		
Cell phone tags		
spatial overlap of seals and fisheries		
Seals as a prey species		
katie moore's talk on what the CC network has found		
Could be Omitted		
IFAW		
the organization of stranding networks		
electronic seal tagging		

5.

How useful did you find:						answered	skipped
						13	2
		not uswful	somewhat	useful	very	no opinion	
	strategies for solutions	1	7	5	0	0	
	networking	0	2	10	1	0	
	identifying issues	1	1	8	3	0	

6.

How useful was the afternoon workshop/discussion?	answered
	7
What did you like about the discussion group?	
seals were finally identified as a problem in the ecosystem	
Great to have whole group involved.	
It was helpful to obtain the commercial fishers view - but it was not well focused	
I appreciated hearing from the fishing community	
getting the honest perspective from the fisherman	
Hearing from all sides of the issue	
opportunity to hear different perspective	
What could be improved about the discussion group?	answered
	10
less technical talk and logistics amongst scientists exclusively	
The fishing reps should have been in the front of the room at a long table. It was distracting to have to keep looking around for the speaker	
better documentation of seal/fishery conflicts	
Identification of the goals, objectives, specific deliverables, and next steps from the workshop	
a little more structure would have been good	
having clearer action points at end of discussion	
besides discussion, NEXT steps in resolution	
breakout to smaller groups	
More solutions	
Make sure facts can be inserted to correct baseless assertions (e.g., codworm effects with the difference between the Canadian fisherman and Jim Gilbert's knowledge of research)	

7.

Please Rate the Quality of the Following						
	low	medlow	medium	medhigh	high	answered
Provincetown location	0	2	3	5	3	13
Accommodations	0	0	2	3	2	7
Meeting/discussion room(s)	0	0	0	9	4	13
Food/breaks	0	0	0	3	10	13

8.

How often would you like to see similar meetings/workshops?		answered	skipped
		13	2
6mos	4		
1yr	6		
18 mos	1		
2yrs	3		

9.

Briefly describe any specific products or outputs that you would like to see as a result of the working group discussions?	answered
	5
seals studied as impact on ecosystem and impact on local economies/fisheries	
I would like to see a summary of the presentations, including major points and comments/responses	
Letters and/or consensus statements identifying concerns/issues that all parties agreed upon.	
Venues/opportunities for next steps.	
An aerial survey, we need a real baseline, 10 years down the road scientists will discuss "retrospective" patterns	
absent a realistic base-line and than "extrapolate" from guesses. Garbage in and garbage out.	
More communication to the general public about upcoming meetings.	

10.

Other suggestions/comments:	answered
	4
less research money grab and more interaction between researchers and fishermen. Would like to see John Levy give a presentation.	
All of the attendees seemed interested in being there, so in that sense I ranked the group size as just right. If you meet again at CCS and you expect the same number of participants, you should consider rearranging the tables, or having large round tables.	
Much of the day's discussion was missing the forest for the trees. Until accurate census/assessments are performed on a regular basis, all other work/research cannot legitimately be given a context and therefore the impact of these results is diminished (or lost all together). Nobody in the room could say with any accuracy or precision what the Gray Seal population level is today; however, it appeared as though only the fishermen were the ones who flagged this as a critical concern. Additionally, it would've been helpful to have all stakeholders comment on their vision for what the marine ecosystem (specifically seals and fishermen) will (should/could) look like in 5-10 years, and how we achieve a preferred "balance" of seals and fishermen in the context of a protection act (mammals) competing with a management act (fisheries).	
Better PA or sound system in room.	

Appendix F: Edited Transcript of Presentations

(Note: information contained in this transcript may be unverified and should not be cited without permission of the report authors)

MORNING SESSIONS

1.) Owen Nichols: "Monitoring seal depredation in the Nantucket Sound weir fishery"

SUMMARY of PRESENTATION:

Nantucket Sound fishermen use fish weirs made of poles driven into the substrate with large-panel mesh strung between them. The bottom of the weir (the "bowl") is made of fine-scale mesh. Depredation of catch by seals has been a problem, as the seals easily go over the trap rim; fishermen have observed partially consumed squid (*Loligo pealeii*) in the heart of the weir. By setting up a DIDSON acoustic camera and a video camera, detailed observations of seal and fish/squid behavior were noted over several 6- to 24-hour deployments. In one 24-hour period, 290 observations of seals swimming past the DIDSON camera were made, as well as seals chasing squid out of the weir's heart. The peak of seal activity was between midnight and 3am, indicating that the seals are habituated not to human presence, per se, but to the site of the weir and the presence of prey. Modifications of weir design, based on images of these interactions, might prevent seals from being able to herd squid and move them out of the weir.

DISCUSSION:

The video showed small fish, such as menhaden, but when asked whether larger prey species like bluefish or striped bass were captured, the answer was no. However, anecdotally, seals are perceived to go after anything in the net, and even remains of false albacores have been found. Questions about how many of the 206 individual sightings were of the same individual were raised. Although photographs were not of sufficient quality to assess this, the gut feeling is that some individual seals do frequent the weirs, how many or how often are still up for debate.

Location and seasonality of the weirs were of interest, and the weirs are located in Nantucket Sound from Chatham to Yarmouth, with some in the Hyannis/Osterville area. The season runs late April to early June, when squid, mackerel, scup, and black sea bass are caught. A discussion of whether seal predation was also extending into Hyannis revealed that at first, there was more predation in the east, less in the west, but another fisherman who recently returned to Hyannis to fish reported that there is more seal activity there, too, when previously he'd had the least-active weir.

A discussion of the historic weir fishery suggested that there were hundreds of aboriginal weirs, and seals were not a problem then. There was no bounty on seals in the 1700s and 1800s, either, so seals must not have been a problem then, either. It was suggested that the seal/fish ratio was different historically.

2.) Dave Johnston: "Assessing spatial and temporal overlap between fisheries and foraging gray seals using high-resolution cell phone tag technology"

SUMMARY of PRESENTATION:

Seal populations in the Gulf of Maine are growing, however, we do not have accurate numbers for their population or accurate information on their interaction with fisheries or the environment as a whole. Seal/fisheries interactions have made news nationally, in salmon farm interactions, at San Diego's Children's Pool, and during the recent gray seal shootings on Nantucket. Internationally, Canada has been advocating for a cull of gray seals since 2008 due to fisheries competition and in 2011 they proposed to cull 75,000 gray seals. In order to accurately assess and understand the interaction of seals and fisheries, we need to know where and when seals are getting entangled, the exact nature of the role of seals in the ecosystem, and the fine-scale details of how gray seals forage. Cell phone tags, developed by Sea Mammal Research Unit (SMRU) in England are an exciting tool that might be of use in answering these questions. They provide GPS-quality location hits, have millisecond resolution, can record a dive profile, and can be both archival and uploaded over cell phone networks. Even in locations without reliable cell phone reception from a major network, temporary "cell towers" can be set up, and the data can be downloaded that way. They have proven themselves already by providing surprising and valuable information when used in Hawaii on monk seals. Cell phone tags provide geospatial analysis that allows the development of fine-scale niche models that can predict foraging habitat, potential interactions with fisheries, how much non-fishery-interaction foraging takes place, and temporal/seasonal changes in foraging and other behavior. A pilot study of four tags on gray seals, would determine how valuable such technology might be for fisheries management. Future studies using harbor seals as well as gray seals, video/image technology, and echosounder studies.

DISCUSSION:

Questions were asked about how tagged animals would be selected. Would they be stranded or entangled animals, or animals from a haul-out? The response was that, ideally, both animals that interacted and that did not interact with fisheries would be tagged. The question of whether gray seals or harbor seals would first be tagged, and the goal is to begin with gray seals. There was some concern that the capture and tagging of gray seals over harbor seals might be more of a challenge, given their bigger size. Starting with harbor seals might be easier. Battery life was

discussed, and the duration depends on the sampling range, but they can last six months to a year. Given the annual molt, timing of tag deployment is critical.

3.) Mendy Garron & Kristen Patchett: "Overview of marine mammal stranding networks"

SUMMARY of PRESENTATION:

In the Northeast, organizations have been responding to stranded marine mammals since the 1970s, but the program was formalized in 1992 with the Title IV: Marine Mammal Health and Stranding Response amendment to the Marine Mammal Protection Act. The national network has a coordinator, support staff, and over 100 organizations in the network which respond to 6,000 animals a year. In the Northeast, from Maine to Virginia, there are 13 organizations with varying mission statements, six of them with rehabilitation facilities. The definition of "stranded" is an animal which is either dead, or alive but incapacitated. In addition to providing immediate care for animals, stranding responses also include blood sampling and screening to try and assess the presence and trends of disease within populations of marine mammals. Another aspect of stranding response is evaluating which animals are good candidates for live release, including assessing whether animals are habituated and might, upon release, be likely to pick fish out of a weir, for example. Nationally, stranding response organizations are trying to develop better tools for taking samples so that population health can be assessed comparatively.

DISCUSSION:

Strandings in the press recently say that "tests are underway," is there any preliminary thought? No. Tests for biotoxin have been done, and now researchers are screening for disease and waiting for recommendations from the working group and additional samples. Nationally, there is concern about what is happening on the west coast as well, which points to the need to move forward with sampling in a standardized method so that the situation can be assessed comparatively.

4.) Katie Moore: "Observations of external fisheries interactions in stranded pinnipeds on Cape Cod and Southern Massachusetts 2000-2010"

SUMMARY of PRESENTATION:

Data from 2000-2010 strandings were examined for evidence of fisheries interaction; species, location, season, and gear type were all queried. To standardize data, particularly how human

interaction (HI) is reported, fisheries interaction was restricted to evidence of gear presently on the animal or signs that there was gear on the animal in the past. Out of 1,328 strandings, 10% (n=132 animals) had HI, 54% could not be determined, and 36% had no HI. Of the HI instances, 74% (n=51) were gray seals. A total of 412 harbor seals were reported stranded, among them HI was 8% (n=35). A total of 495 harp seals were reported stranded, among them 4% (n=21) were HI, and 29% of those (n=6) were fisheries related. A total of 305 gray seals were reported stranded, among them 22% (n=68) were HI, and 75% of those (n=51) were fisheries related. The peak of HI instances were in May, June, and July, with another small surge in September. This was not an indication of effort bias, because the highest number of reports occur during the winter months. In the instances of fisheries-related HI, 67% had gear presently on the animal at the time of stranding. 72% of the entanglements were of monofilament of varying mesh size. 15% were multifilament netting, 9% were pot/trap gear, and 4% were random (mooring lines, dock gear). Most entangled animals were juveniles and subadults, which might indicate that the entanglements are lethal to animals, preventing them from reaching adult size.

DISCUSSION:

A suggestion was made that fishing activity might want to be part of the study, so that it can be assessed in relation to entanglement. When asked about how monofilament mesh sizes are measured, it was revealed that the gear is measured and also sent to NOAA for evaluation. One thing going forward that needs to be one is to interview fishermen to see if seals are being cut out of nets or are breaking out. Some of that is being done by PCCS, but more is called for. One suggestion was put forth that harbor seals are drowning in the gear while gray seals are breading out or being cut out and released alive. The range of gray and harbor seals overlaps, so entanglements should overlap more. Figuring out the difference of entanglement rate should be a priority. Is it due to diet, foraging location, or behavior in the nets?

5.) Greg Skomal: "What is the ecological role of the gray seal as a prey species?"

SUMMARY of PRESENTATION:

The recolonization of gray seals in the Gulf of Maine also affects the animals that eat them, such as great white sharks. Distribution and life history of great white sharks are poorly understood. Great whites have been considered a rare event species in the western North Atlantic, but an increase in sightings in the Cape Cod area has occurred in recent years, as well as evidence of shark/seal interactions, mostly in the Chatham area. Over Labor Day weekend in 2009, 5 great white sharks were tagged from the F/V *EZDuzIt* using a harpoon technique. All five were immature, so their presence was more likely due to food availability rather than reproduction. Results showed that the migratory pattern of the sharks was fairly simple, moving from northeast to southeast over the continental shelf. In September - October the sharks were

off of Cape Cod, and in February – April they were off of Jacksonville, Florida, where some evidence shows that they might be scavenging upon North Atlantic right whales. In 2010, six more great white sharks were tagged off of Monomoy; their movements were more varied. One went to the Gulf of Mexico, one stayed off the coast of Georgia, and most stayed between the surface and 20-30m. One, a large female estimated to be 50+ years by her size, went toward Sable Island, then headed toward the Sargasso Sea, which is considered to be a more "typical" movement pattern for great white sharks; she stayed mostly between 500 and 700 m deep. In 2011, nearly 20 great white sharks were tagged with acoustic tags, and receiver stations were set up to determine residency, site fidelity, and nearshore movements. The hope is to examine Cape Cod for "hot spots" of seal predation, as they have in South Africa and the Farallon Islands of California. Future studies include an examination of shark populations around Muskeget Island, the largest gray seal breeding site in the United States, and a more detailed understanding of seal/shark interactions.

DISCUSSION:

The status of pre-colonial great white sharks was asked, but there is no information.

6.) Sharon Young: "Too many seals in the sea?"

SUMMARY of PRESENTATION:

In 1497, John Cabot described huge quantities of fish and fish predators, including seals, around Cape Cod. Current population estimates of seals in the Gulf of Maine are outdated and/or unknown; the most recent numbers are from 2005. To assess what is "too many" the concepts of "biological carrying capacity" and "sociological carrying capacity" need to be defined and distinguished. The first is how much the ecosystem will sustain, the second, how much people will tolerate. This is an old debate, with strong voices advocating for both the culling of and the protection of seals. However, in 1972, the United States passed the Marine Mammal Protection Act, and in 1994 and amendment to that act ended the right to intentionally kill marine mammals to protect fishing gear and catches. The same amendment did allow a limited incidental take. Section 120 of the MMPA allows a limited intentional take if the pinniped species is not listed as endangered, but an "expected benefit" from the cull must be demonstrated, and other factors that are affecting the fishery (ie: habitat loss) must also be considered. Additional waivers allow government employees to kill pinnipeds as part of their official duties if they are considered to be a public menace. Waivers may also be given to tribes, states, and governments, but they must be in line with the MMPA and must allow public comment. Section 109 allows the transfer of population management back to the state, if the marine mammal stock is at optimal sustainable population (OSP).

There have been recent challenges to the MMPA. Since 1994, an aquaculture task force in Maine began examining harbor seal predation; the Makah tribe of Native Americans in Washington State petitioned for a waiver to hunt gray whales; Section 120 was invoked to cull California sea lions eating salmon at the Ballard Locks in Seattle, Washington; Section 120 was invoked again (and the petition dismissed) in 2007 on the Columbia River of Washington, Oregon, and Idaho to cull California sea lions at the Bonneville Dam, and then the application was filed again in 2011; there were 24 shootings of sea lions on the Washington coast in 2010. Generally, the sentiment seems to be that people want broader authority to kill "nuisance animals," and more amendments to the MMPA and bills to congress, including a 2011 bill allowing one to kill any pinniped seen eating salmon on the Columbia River. Native American tribes on the Columbia River want to say that California sea lions are now OSP.

DISCUSSION:

Discussion included questions about how OSP might be determined for gray seals, however, the problem is that understanding of historic numbers of gray seals is not firm. Without that, the way to evaluate OSP is by examining the rate of gray seal reproduction. Once the reproductive rate begins lowing, the population is probably nearing its maximum. An obstacle to determining population growth rates is that we do not have much contemporary basis for comparison. NOAA did pup counts on Muskeget Island and Seal Island in the 1970s, but now we only have raw counts from aerial surveys, and that does not factor in immigration from Canada. Photo-identification using tags and branded animals prove that gray seals are a Northwest Atlantic population, irrespective of national borders, and thus what happens on Sable Island is directly linked to what happens in New England. A growth rate of 12% per year is assumed to be the maximum. Sable Island in Canada was at 13% but has recently slowed.

7.) Stephanie Wood LaFond: "Gray seal pup tagging in the Northeastern United States 2002-2005"

SUMMARY of PRESENTATION:

There are three gray seal pupping sites in the United States: Muskeget Island off of Nantucket Island and two sites in Maine. Pups were tagged at these locations in order to study genetics, take measurements, evaluate and describe molt, and get resighting information. 105 weaned pups were tagged with flipper tags. Of those, only one was resighted. It was tagged in 2004 in Maine and resighted in 2009 in Chatham. Clearly, while flipper tags are inexpensive and relatively non-invasive, they are not an ideal research tool. The problem with flipper tags is twofold: first, the tags don't last. 40% are gone by the time a seal reaches age 6. Secondly, they

are difficult to see in the field, and when they are seen, there is no centralized database where the tagging institution/researcher is listed, so reporting sighted tags is quite challenging even for researchers in the pinniped research community.

A side note on the historic/prehistoric numbers of gray seals in New England, a topic which has come up several times in our discussions. If you look at archaeology, both gray and harbor seals were part of ecosystem prehistorically. In shell middens, it is clear that seal hunting was happening with weir fisheries. On Martha's Vineyard, a study looked at six midden sites. In 4 of 6 sites, archaeologists found gray seal remains over several hundreds to thousands of years. Seal remains have been found down to New Haven, Connecticut, indicating that this was part of their former range as well. In Maine, researchers found that from ~2000 BC up until the 1400s, gray and harbor seal hunts went from a seasonal to a year-round activity. There was a further increase in hunting pressure during pre-Colonial times.

8.) Andrea Bogomolni "A sighting database for uniquely identifiable pinnipeds"

SUMMARY of PRESENTATION:

At the conclusion of the 2009 Seal/Fisheries Interaction Meeting, a database that could be shared between research communities was the first priority. This database would ideally increase the ease and thus the rate of reporting opportunistic sightings, and would make information-sharing easy, accessible, and useful. To be useful, people should be able to enter sightings anonymously, the database should be able to filter out "spam," there should be an associated smart-phone app for entries in the field, the database should be easily linked to other networks outside of New England, and there should be a way to tie sightings reports to local stranding networks if an animal is entangled or stranded. Such a database would allow researchers to re-sight individuals and gain understanding of individual movements, identify "nuisance" animals, identify "weird" interactions (ie: a seal eating a duck), and generally monitor changes in population and environment via anecdotal information.

DISCUSSION:

Tag systems of various organizations was discussed, and the fact was mentioned that on the west coast there is centralized tag distribution, with one organization giving out tags color-coded by island and sequentially numbered. The iPhone app used by the Alaska stranding network could be used as a model, and the electronic ID guides that are being done might also be useful to look at, as well as Cornell's eBird program. Mockups of the database were sketched, and the need to incorporate guidelines for "citizen scientists" in terms of how to appropriately approach and/or interact with wild pinnipeds was emphasized. Brands should be mentioned in the

database, too. One challenge will be to help the general public provide information that is clear and standardized enough to be useful to researchers, yet easy enough for someone to enter who might not be very familiar with pinniped terminology/biology. One solution might be to have questions to lead the person making the report (ie: What side of the body is the scar on?), and a comments section for non-standardized information as well as the ability to attach one or more photos will be essential.

One issue to be addressed is who will be in charge of the database, making sure that it runs and that the information is vetted in some way. The right whale consortium model is one way to go, and the Wikipedia model, where researchers, administrators, and "citizen scientist" reporters have different levels of access, is another. Either way, the database needs to be interactive, and once it's built, word needs to get out via the press and local stranding networks that it exists. A publicity plan will be key.

Other features to add: facial recognition software, prompts to "report a stranded animal now" so that local agencies are immediately notified, the ability to interact with other databases such as the national database for rehabilitated and released animals (which means using the same names for various fields and cross-platform compatibility). Perhaps automatic notification to tagging institutions if one of their animals is resighted could be incorporated.

AFTERNOON

Gordon Waring: "What we do and don't know about population abundances about seals locally… and why."

History of seal research in New England: In the 1980s, there were some studies of harbor seal bycatch in gillnet fisheries. 1976 was the first systematic harbor seal survey in the Gulf of Maine. 5,000 – 7,000 seals were counted, and that's the basis for the "historic numbers" we have for seal populations. Prior to that, there were only numbers of seals brought in for the state bounties.

In 1976, gray seals were considered to be a "rare species." Surveys were done in the 1980s through the 1990s. In the late 1990s, surveys from New Hampshire to Eastern Long Island began. Follow-up to surveys to Manomet began in the mid-1990s. There started to be more documentation of gray seals.

In the early 1980s, Valerie Rough, working on Muskeget Island, documented recolonization of United States areas by gray seals. She documented the first pupping of a seal from Sable Island in US waters. In the late 1990s, there were monitoring surveys. In 2001, a large-scale harbor seal survey was launched which involved tagging some animals.

After that, funding dried up for seal work. There was money available for right whale surveys, so NMFS borrowed time from September through April to conduct aerial monitoring surveys from Plymouth out to Nomans. The goal was to do 1-2 surveys a month at low tide. Stephanie Wood developed a study to focus on the gray seals in Muskeget and Maine.

Since 2005, NMFS has done annual monitoring flights from Plymouth to Nomans, but researchers are just getting around to counting the seals in those images now. The surveys will give trend data on harbor and gray seals in winter, late fall, and early spring haul-outs. The data will also document the shift from 100% harbor seals to almost 100% gray seals using the haul-outs.

Historically, Mike Paine suggested that harbor and gray seals extended down the mid-Atlantic coast. Through Riverhead foundation, we know there are long-term haulouts of harbor seals and now gray seals are moving in. This past summer, harbor seal haul out in Oregon Inlet for past 2 years…. a seasonal haulout. Gray seals will probably continue to move south.

Last year (2010), NMFS and associated organizations planned a capture for harbor seals to get updated harbor seal abundance numbers, but fog prevented the capture.

Recently, funding was received to do assessments for all marine mammals, so some funding was kicked over to seals. Hopefully this will happen again, and numbers for harbor seals as well as pup production for gray seals will be established. The problem is making the pitch that "this is the priority." It's a hard time.

There is a need to figure out what approaches to take as well as what questions need answers, and then move them up to the federal government or outside sponsors. Seal research has been done on a shoestring budget. We need to make this a priority.

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16. Abstract (Limit: 200 words)

On October 28, 2011, a diverse group of over sixty commercial and recreational fishermen, scientists, and resource managers gathered at the Provincetown Center for Coastal Studies (PCCS) to discuss interactions between seals and fisheries and develop integrated research strategies for addressing these concerns. The workshop, "Gulf of Maine Seals: Fisheries Interactions and Integrated Research", was sponsored by the Woods Hole Oceanographic Institution (WHOI) Marine Mammal Center and organized by researchers from PCCS, WHOI, the University of Connecticut (UCONN), the University of Massachusetts (UMass), and the University of New England (UNE). The workshop followed a series of informal meetings between PCCS staff and the Cape Cod fishing community, during which scientists met with commercial and recreational fishermen at ports, community centers, and association meetings. In order to ensure that the fishing community had a distinct voice, a forum was included in the Oct ober workshop agenda, during which fishermen were encouraged to share their observations, experiences and concerns. Separately, moderated discussion groups composed of all participants focused specifically on fisheries interactions, seal tagging and tracking, and management issues. The recommendations from all four sessions shared common themes, including the need for collaborative research involving both the scientific and fishing communities. Participants identified data gaps regarding seal abundance estimates, movements, and diet; and proposed the need for several long term and short term research projects, including studies of seal depredation in recreational and commercial fisheries, tagging and tracking seals to assess movement and overlap with fisheries, and ecosystem-scale analyses of the potential for competition. Workshop organizers proposed a database to share data among collaborators and development of a consortium to foster collaboration among managers, researchers and the fishing community.

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